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ABSTRACT

METRO-APEX is a computer based gaming simulation in which students study a large urban city and its surroundings by playing the roles of city and county politicians, industrialists, environmental control officials, city planners, land developers, and labor groups. METRO-APEX was played once a week for five weeks as part of one credit course in political science. The decisions made by the student players were coded at the end of each session and used as input to the METRO-APEX computer program. The output from the program told each player what has happened to the city during the year as a result of his input decisions, and served as a basis for the next session. Student evaluations of this learning experience were very positive. If the simulation is well designed, the computer programs are thoroughly tested and debugged, and sufficient funds and competent staff are available, such computerized simulations can enhance the learning experience in higher education. (Author/CMV)

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COMPUTERIZED GAMING AND SIMULATION IN HIGHER EDUCATION: THE METRO-APEX EXPERIENCE

BY

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Computerized Gaming and Simulation in Higher Education: The METRO-APEX Experience

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Abstract

Simulation is an educational technique which allows students to learn by participating rather than by listening or watching. There are many different types of simulation games available to educators some of which use the computer to lyze pa decisions and calculate results.

METRO-APEX is a computer-based gaming simulation in which students study a large urban city and its surroundings by playing the roles of city and county politicians, industrialists, environmental control officials, planners, land developers, and labor groups. Each cycle represents one year in the city. At Rutgers METRO-APEX was played once a week for five weeks during the fall of 1975 as part of a one credit course. The decisions made by the players were coded at the end of each session and used as input to the METRO-APEX computer program. The output from the program told each player what had happened to the city during the year as a result of these decisions and served as a basis for the next session.

This paper will discuss METRO-APEX as a specific example of how simulation and the computer can be used to further the learning experience in the undergraduate curricula.

During the fall of 1975, Professor David Rosen of the Department of Human Ecology and Social Science at Rutgers University offered a one credit course entitled "Lab. in Political Science." (The course is being offered again during the spring of 1977.) The basis of this course is a computerized simulation called METRO-APEX which is described below. Because Professor Rosen had very little computer background or experience, a cooperative arrangement was made with the University's Center for Computer and Information Services (CCIS), and this writer was assigned to the project. All of the computer aspects of the simulation were handled by CCIS including putting up a new version of the METRO-APEX program on the system, creating all the necessary files, overseeing the preparation of the input data, doing the actual processing, detecting errors in the output and making the necessary corrections, etc. Professor Rosen served as the Game Overall Director (G.O.D.), was in charge of the "gamed" environment as described below, conducted the all-important debriefing session, assigned and graded student papers and in effect dealt with all the aspects of learning and education.

The METRO-APEX Simulation

METRO-APEX is a "computer-based gaming simulation. . . designed to provide a laboratory urban community in which air pollution management trainees. . . apply and test the knowledge and skills gained through conventional educational methods." [1] It evolved from a similar exercise (M.E.T.R.O.) developed at the University of Michigan. In 1966, the Division of Air Pollution Control, U.S. Public Health Service, awarded a grant to the COMEX Research Project, University of Southern California, to expand the original work. The universities worked together to

produce the initial METRO-APEX simulation in 1971, as well as a revised and updated version released in 1974. [1]

METRO-APEX is a simulation rather than a game. It analyzes and interrelates players' decisions according to a very complex model with the use of a computer. Players are not directly pitted against one another in order to determine a winner. (The minor exception to this is the election model which may or may not be used at the discretion of G.O.D. See below.)

In effect there are two essential components to METRO-APEX. One is the "gamed" environment during which the players assigned to the various roles interact with one another and make decisions. Each of these sessions (or cycles) lasts approximately three hours and represents one year in the life of Apex county.

The second component is the group of computer programs which "predicts the changes that occur in several sectors of the urban system in response to the decisions made by participants in the 'gamed' environment, decisions made by persons outside the 'gamed' environment (other actors whose behavior is simulated in the computer), and external pressures on the metropolitan area (also simulated in the computer)." [1] The computer analyzes the decisions made by the players, calculates the changes in the status of the community and generates output. This output in the form of tables, maps, summary reports, financial statements and a newspaper is given to the players who use the information as the basis for the next cycle.

The roles to which the players are assigned are as follows:

1. City and county politicians whose job it is to administer their respective jurisdictions. They prepare budgets, allocate funds, pass laws and initiate and manage programs.

2. City and county planners who assist politicans and develop long-range plans by which the community may be guided.

3. Environmental Quality Agency which consists of an air pollution control officer, a solid waste manager and a water quality manager. These people formulate policy, monitor the levels of pollution and are responsible for "cleaning up" the county.

4. Land developers who buy and sell land, and build homes, apartment buildings and commercial establishments and attempt to sell them at a profit.

5. Industrialists who manage their individual companies. They set prices for their products, determine production levels, select fuels, decide on pollution controls, negotiate with union leaders, declare dividends to stock holders and are generally responsible for seeing to it that their companies make money.

6. Pressure groups such as the Tax Payers Association and the Minority Action League who urge the politicians to pass legislation according to their needs and who attempt to gain support for their projects from the other players.

7. News Media which advocates or disapproves of government decisions, sets editorial policy, reports the activities of the players and covers all the important news stories.

8. Labor Council which annually negotiates labor contracts with each of the industrialists. The Council proposes annual salaries, number of sick days and vacation days, health insurance coverage, retirement fund contributions and other fringe benefits. If labor and industry cannot reach an agreement, they may consent to binding arbitration, the union may strike or management may conduct a lockout. (Note: The labor model is not part of the METRO-APEX package from COMEX. It was designed and written by Alex Jones of Princeton University and is a fine addition to the simulation.)

For each of the roles outlined above there must be a role advisor who serves in several capacities. This person meets with his or her players at the beginning of the first session to give detailed instructions on the rules under which the players must operate. The advisor describes and outlines the roles of the players and explains how to fill out the work sheets. (The work sheets, which are unique for each role, are designed to help the players put their decisions on paper.) During each cycle, the role advisor answers questions and generally oversees the functioning of the players. At the

end of the cycle the advisor codes the information from the work sheets to special coding forms. The data from these forms are later keypunched and used as input to the computer programs.

Overseeing the entire process of the simulation is the Game Overall Director (G.O.D.). This person begins the first cycle with a short talk outlining the general rules, introduces the various roles and describes the geographic layout of Apex County. During each cycle the game director must constantly make rulings and settle disputes. This usually requires simulating additional roles such as labor arbitrator, judge, sheriff, state legislature, governor, Federal Government, etc. The director may assume some of these roles or assign them to the role advisors.

It is impossible to detail all aspects of this simulation in these few pages (the METRO-APEX manuals total 21 volumes). By describing its use at Rutgers University, perhaps the reader will be able to visualize how it works.

Thirty-five undergraduates registered for the course which was scheduled to meet one evening a week for six weeks. Each student was assigned a role and given some introductory material a few days before the course began.

When the students arrived, they were given tags which contained their names and roles. Several large tables were set around the room with signs indicating the location of each of the various groups (e.g., developers, county politicians, etc.). Copies of the *Metro-Apex News*, the local computer-produced newspaper, were distributed as well as a computer printout applicable to each role which had been created from a preset initial cycle. After the preliminary introductions from G.O.D. and the role advisors, a prerecorded news broadcast was played on the tape recorder, and the simulation officially began.

For the first hour or so things were fairly quiet as the students familiarized themselves with their roles. They read the newspaper which described several issues requiring a vote, and they completed their opinion polls. Soon labor and industry began negotiations, the Environmental Quality Agency pushed for legislation requiring industry to meet certain minimum standards with sanctions if they refused, the developers began negotiations with the county politicians to build low-income housing and the planners proposed zoning changes.

After the session ended, the coding was completed, news articles were collected and the tabulations from the opinion polls were recorded. The following day after all the data had been keypunched, the computer work began. The initial program run indicated errors on some of the input cards, and careful scrutiny of the output revealed inconsistent results (negative balances, unpaid taxes, etc.). The input cards were changed and many of the errors were corrected. However, it took two more runs before acceptable output was obtained.

When the students returned the following week, they were anxious to see the computer output and to find out what had happened. During the second cycle G.O.D. announced that elections would be held during cycle four, and the results would be announced in cycle five. All incumbent politicians chose to run again and a slate of opposing candidates was drawn from among the other players. Campaigning began and campaign contributions were solicited all during the next two cycles. This, of course, went on concurrently with the rest of the simulation.

Because of the complexity of the model, no two METRO-APEX simulations are alike, and many interesting issues and projects can and do arise. During the Rutgers simulation, for example, the county hospital facilities were expanded, a solid waste treatment plant was constructed, hearings and litigation resulted when Shear Power Company requested a rate increase, and a master plan was devised and accepted which included land usage, capital improvements, environmental control, etc. Also, during one cycle a county politician sued the *Metro Apex News* (played by this writer) for libel and slander. Lawyers were hired, a judge was appointed to hear the case, and all had their day in court.

A final example of learning from experience occurred with one of the industrialists. His brewing company had done so well and had made so much money, that during cycle two he purchased land and expanded his plant facilities. In cycle three he increased his production and came back the following week expecting that he had made a fortune. However, he overestimated the market capacity and instead of selling nine million barrels of beer, he sold five million. Naturally his raw materials costs were up, as were labor and fuel costs. In addition, he now had to pay more than $1 million to carry his inventory over from one cycle to the next. Instead of having a $5 million cash reserve, he discovered that his company was $4 million in debt—but he sure had lots of beer on hand!

During the course of the simulation, the players are led to believe that they will participate in more cycles than actually will be played. This is to prevent wild, speculative decisions from being made during the last round. When the players arrive, for what they believe is the last cycle, they discover that the simulation has ended, and a debriefing is conducted.

Perhaps the most important aspect of a simulation is the debriefing. At this time the players and G.O.D. discuss and review what has taken place. The theories and concepts underlying the model are brought out, and the model itself is critiqued as to how well it relates to the real world.

When played at Rutgers, the course was scheduled to last six weeks, but at the beginning of cycle five the prerecorded news broadcast prepared by G.O.D. announced that Apex County had been completely destroyed by a nuclear blast! During the ensuing debriefing session, three very interesting results emerged. After each of the players briefly recounted his or her experiences, the group was amazed to learn that there were vast areas of ignorance and misconceptions concerning the roles of the other players. The industrialists and the Labor Council were totally unaware of what the county politicians were doing. The land developers had no idea of problems confronting the Environmental Quality Agency, etc. This was then related to real-life situations where individuals are often so involved with the "trees" that they are unable to see the "forest."

Secondly, the students discovered that within the group there were grave perceptional differences of the same event. There were wide discrepancies among the various reports of "what happened."

Lastly, during a critical analysis of various aspects of the model, the students realized that often what appeared at first glance to be a flaw was actually a true representation of the real world. A striking example of this was the air pollution control officer who claimed that simulated aspects of the model caused apathy among the politicians in passing strong legislation and resulted in the resistance of the industrialists in installing pollution controls. The other players, however, quickly pointed out that these very factors have prevented most major industrial areas in the country from solving their pollution problems.

Although the students were overwhelming in their praise of the simulation as a teaching technique (see evaluations below), from an administrative point of view there are difficulties in using METRO-APEX. One factor essential to success is a knowledgeable and qualified staff. This includes:

1. Experienced role advisors (preferably people who have participated in METRO-APEX previously).
2. An experienced keypuncher (ideally one who is familiar with the control cards required by the program).
3. A computer person (or two) who is completely familiar with data management, JCL, the program and the output, and who understands the interrelationships of the roles (e.g. a miscoded value on the county politicians' budget card will cause the decisions of the air pollution control officer to go awry).
4. Additional personnel to duplicate, staple, separate computer output, post maps and tables, help set up and clean up, and generally see to dozens of details.
5. A game overall director who understands the simulation technique and who is

completely conversant with all of the complexities of the METRO-APEX simulation.

In addition to staffing, the other major consideration to using METRO-APEX is the cost. Although the computer programs are distributed free of charge, the manuals are expensive and the computer operational expenses can be very high. (CPU time and computer paper and printing costs can run from $120 to $200 per cycle depending on the number of runs required to correct coding and keypunch errors.)

Obviously, a professor cannot lightly and frivolously undertake the production of a simulation of the magnitude of METRO-APEX. It requires a great deal of time and effort on the part of many people, especially the G.O.D. and the computer person. On the other hand, the flexibility and complexity of this simulation are the factors which make METRO-APEX so exciting, instructional and effective as a teaching technique. Excerpts from the written evaluations required of each student and from a report prepared by David Rosen speak for themselves:

Excerpts from Student Evaluations

"I am a history major and all you do is go to class and listen to lectures—for a change here was a class that dealt with reality and concrete problems."

"Participation in the simulation was very interesting. I learned a great deal about budgets, financing of government projects, interest group influence. . . the simulation clarified topics studied in Dr. Rosen's environmental politics course."

"This course definitely ranks among the best I've ever had."

"It was a rewarding, interesting and instructive course. I learned what it was like to be in a decision-making role; the factors, influences, considerations, priorities and benefits. I learned a great deal about myself and about human nature. If it runs next year, I would personally enjoy participating as a role advisor."

"The simulation was extremely interesting. What a challenge! A totally new type of learning experience. . . I think everyone should take this course."

"This simulation is one of the most interesting courses I have taken. I really saw how the institutional imperative works. It's such a change of pace from the traditional classroom and lecture."

"The simulation made me look forward to Tuesday nights. It was fun. I enjoyed it, but most importantly, it was of great educational value in two ways. One, it taught me the lesson of working with people, and two, it showed a realistic, even if controlled, political system. I was glad to be part of it. It will always be part of me."

"The one main thing I learned was that there exists a vast gap between the idealism of texts and classrooms and the 'reality' of a complex simulation, like METRO-APEX. In a class it all sounds so easy to balance a budget, assign priorities, clean up the environment. There is no doubt in my mind that of all my classes this is the best I have seen."

Excerpts from a Summation Report by David Rosen

"The overall assessments of the course are overwhelmingly positive. According to the evaluations no students found the course to be uninteresting or useless and a number regarded it as the best course they have ever taken.

"Many students felt that the simulation related directly to their work in other courses.

"A number of students said that the simulation increased their interest in their 'real world' equivalents and found they were paying more attention to local politics.

"Many students asked for more theory so that they could better understand what had happened in the simulation. To any of you who have attempted to teach highly theoretical material to undergraduates, it will be clear how remarkable it is for students to ask for theory.

"Many students indicated that the simulation would be more valuable if it were supplemented with lectures and readings and made a full three-credit course."

Conclusion

Although this writer does not advocate that standard lecture presentations be completely discarded in favor of simulations, she does suggest that gaming and simulation techniques have a place in higher education. The computer provides the power to make the model sufficiently complex so that the simulation does not become a trivial exercise. The use of the computer also frees the students and the professor from the drudgery of endless, time-consuming calculations, and allows them to focus their attention on the theories and concepts involved. If the simulation is well-designed, the computer programs are thoroughly tested and debugged and sufficient funds and competent staff are available, then institutions of higher education can offer courses which combine theoretical concepts with the equivalent of "on-the-job training," and thus provide their students with a superb learning experience.

Note

Additional information on gaming and simulation may be obtained from sources two and three listed in the bibliography.

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